# Green Zia Analysis of
# Johnson Controls Northern New Mexico
# Aerosol Cans

## Background

Johnson Controls Northern New Mexico (JCNNM) is the facility support subcontractor to the Los Alamos National Laboratory (the Laboratory), in Los Alamos, New Mexico. JCNNM operates and maintains the Laboratory's facilities, equipment, property, grounds, infrastructure, and public and private roadways covering over 27,800 acres. All JCNNM work is conducted on behalf of the Laboratory and Department of Energy (DOE).

JCNNM services include heavy equipment operation in support of roadway maintenance, sanitary waste collection, recycling operations, construction activities, utilities work, grounds maintenance, and transportation, among others. During DOE Fiscal Years (FY) 1998 and 1999, JCNNM generated approximately 1600 waste aerosol cans per year. As part of its commitment to pollution prevention (P2), the JCNNM Environmental (HENV) Branch initiated an effort to identify management alternatives for waste aerosol cans. Working with the Laboratory's Environmental Stewardship Office (ESO), JCNNM HENV personnel began a systematic process to evaluate and implement P2 opportunities for aerosol cans.

This paper presents the approach used by JCNNM and ESO to reduce pollution from waste aerosol cans. This approach utilizes the *New Mexico Green Zia Systems Analysis Tools* (Green Zia tools), as specified in Function Area 3 (Managerial Accomplishments) of Section B, Part II-1, Appendix F of the DOE/University of California contract (2000). The Green Zia analyses employed in this project were generally accomplished according to the New Mexico Green Zia Environmental Excellence Award Program guidance at *http://www.nmenv.state.nm.us*. This is one of three Green Zia analyses that JCNNM has completed to satisfy Goal 3 of Performance Measure 29, "Hazardous Waste Generation," in JCNNM's contract with the Laboratory.

This paper discusses the application of the following tools:

- Process mapping of aerosol can waste management activities;
- Identification and rank ordering of P2 opportunities;
- Root cause analysis;
- Activity-based costing analysis;
- Consensus problem statement;
- Generating P2 alternatives;
- Selecting a P2 alternative; and
- Implementing the selected alternative with a formal action plan.

JCNNM has an ongoing and formal P2 program committed to reducing waste and environmental releases. The P2 program is documented in a written plan (*The Waste Minimization/Pollution Prevention Program Plan for Calendar Years 1997 through 1999*, SPI 12-31-012) and P2 practices are incorporated into operating procedures, where appropriate. In addition, JCNNM has P2 performance measures included in its contract with the Laboratory, which influence the subcontract award fee. These documents specify JCNNM's commitment to preventing waste at the source, while also recycling and minimizing waste that cannot be prevented. The performance measures outline P2 requirements, establish numeric goals for reduction of wastes,

require tracking and reporting of progress toward meeting the goals, and provide incentives or rewards for waste reduction. Under JCNNM's P2 program, Department Managers (and others who supervise waste generating operations) are challenged and required to incorporate P2 practices to the extent technically and economically feasible.

**The Challenge**

From October 1999 to August 2000, JCNNM generated approximately 232 kg of waste aerosols. Although this is not a large waste stream when considering its total weight, it accounts for approximately 1600 aerosol cans and nearly eight full 55-gallon drums.

The challenge for JCNNM and ESO was as follows:
- Develop a process map for waste aerosol can management;
- Determine the costs and liabilities associated with the current waste aerosol management process;
- Identify, rank, and implement alternative management processes that reduce the costs and liabilities associated with waste aerosol cans;
- Identify, rank, and implement alternatives for waste source reduction; and
- Compare and contrast the costs under the current aerosol management process with the anticipated costs under the proposed alternatives.

**Green Zia Petroleum Aerosol Management Team**

A multi-disciplinary team was formed to address waste aerosol can management. The team included personnel familiar with aerosol can use, as well as those knowledgeable about management and recycling of RCRA hazardous wastes. The following individuals were team members:

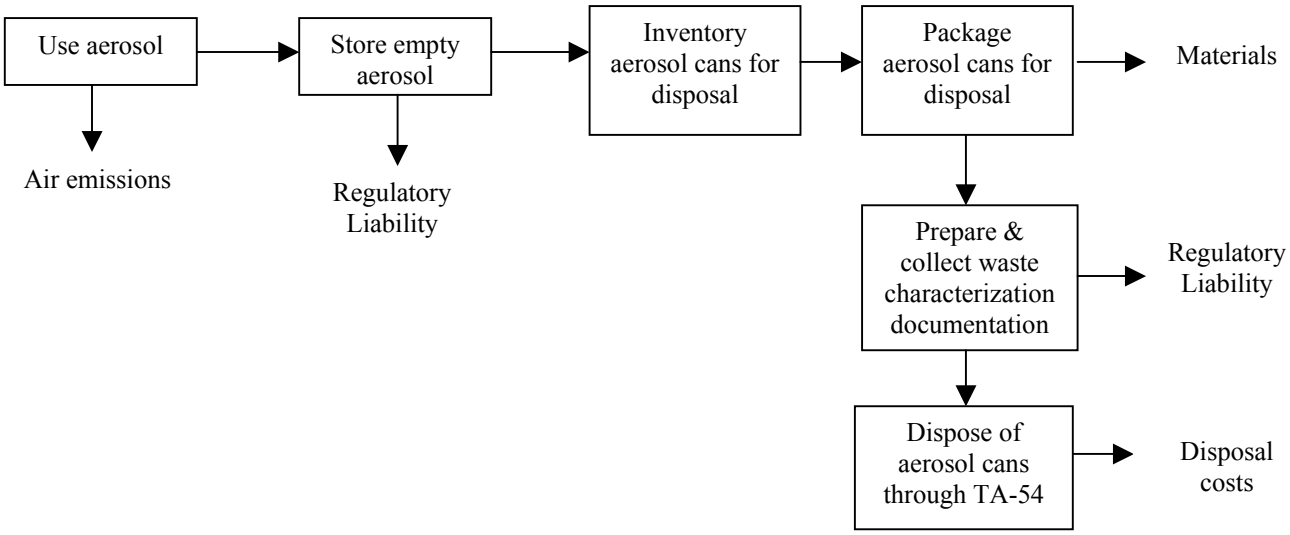
- Jan Watson, Sanitary Waste Minimization and Recycling Project Leader, ESO, LANL;
- Brian Carlson, Low-Level and Mixed Low-Level Waste Project Leader, ESO, LANL;
- L. Vince Rodriguez, RCRA Program Coordinator, JCNNM-HENV/BEC;
- Suzanne Moore, Environmental Manager, JCNNM-HENV/BEC;
- John Kelly, Hazardous Waste Operations Team Leader, FWO-SWO, LANL; and
- Jim Stanton, P2 Program Coordinator, JCNNM-HENV/BEC.

This team met on several occasions to complete the work on this project.

**Process Characterization**

The team prepared a process map describing the typical management of waste aerosols (see Figure 1). Each step includes labor costs, which are not shown in Figure 1, but are addressed under Activity Based Costing, below.

**Figure 1. Detailed Process Map Illustrating Waste Aerosol Can Management**




**Root Cause Analysis**

Waste aerosols are RCRA hazardous waste because their contents and/or propellants may be hazardous (e.g., listed or characteristic) wastes and because aerosol cans may be capable of detonation or explosive reaction if subjected to a strong initiating force or if heated [40 CFR §261.23(c)(6)]. JCNNM and the Laboratory have not yet established a recycling pathway for aerosol cans that meets 40 CFR Part 261 requirements and relieves the regulatory burden associated with aerosol cans. While The Laboratory is pursuing several management strategies for aerosol cans, JCNNM completed this Green Zia analysis under and in response to the current management strategy.

**Statement of Problem**

Waste aerosols are JCNNM's fifth largest waste stream for DOE FY 2000 and therefore constitute a significant liability. Under the current disposal process, JCNNM is required to provide FWO-SWO with a complete inventory of waste aerosols before they are shipped to TA-54 for storage. This includes several labor-intensive activities such as manually writing each aerosol's name on the CWDR, attaching an item identification number to each aerosol, and copying an MSDS for each aerosol to be included with the CWDR.

The team identified several items (beyond the labor-intensive management process) that hinder compliance efforts:

- Conflicting information about the regulatory status of waste aerosol cans;
- Lack of employee awareness of the proper management of waste aerosol cans; and
- Lack of an acceptable and appropriately documented recycling pathway.

**Generating Process Alternatives**

In response to the problems stated above, the team used a brainwriting tool to develop waste aerosol management alternatives. The alternatives identified are as follows:

1) Stop using aerosols completely.
2) Accumulate aerosols for direct off-site shipments for disposal.
3) Accumulate aerosols for direct off-site shipments for recycling.
4) Continue disposal/recycling through TA-54.
5) Purchase and operate passive aerosol can puncture units for the primary generators.
6) Contract with an outside recycling agency (i.e., Nambe) for can management/recycling
7) Begin operating the bio-filtration aerosol-puncturing unit.

**Selecting an Alternative**

Members of the Green Zia Aerosols Management team used a variety of tools to select an appropriate P2 alternative. Initially, the team used a bubble-up/bubble-down tool to combine and categorize alternatives. During this process, some alternatives were eliminated based on feasibility, cost, and liability concerns. For example, the team determined that it was not feasible to eliminate aerosol can usage entirely because of their prevalence, ease of purchase/use, and increased health and safety concerns associated with non-aerosol products. Also, the team rejected contracting with an outside recycling agency due to potential liability issues.

JCNNM reviewed the bio-filtration unit's feasibility for operation. While the unit is attractive for a number of reasons (i.e., the unit is on-site and represents a business development option for JCNNM), the team believed it was too complex to be a feasible option. For example, the unit requires constant sources of electricity, water and pressurized air, which complicate the siting process and increase the unit's operating costs. Further, the unit's capacity is ten times more than the aerosol can waste generation rate of JCNNM and the Laboratory combined. This means that to keep the unit operational, JCNNM would need to purchase feedstock for the microorganisms or procure expensive add-on equipment to handle waste rags or other solvent-contaminated material. Investigation with ESH-19 indicated the add-on equipment would likely change the status of the unit from a recycling unit to a waste treatment unit, which would require permitting. Based on these concerns, the team rejected the bio-filtration aerosol-puncturing unit alternative.

The team used an activity-based costing analysis to further examine the following alternatives:

1) Continue disposal/recycling through TA-54 using the WPF/CWDR system. This is the "No Action" option.

2) Purchase and operate passive aerosol can puncture units for the primary generators. This option reduces costs by eliminating the need for listing all the aerosols on a CWDR, putting FWO-SWO item identification numbers on the aerosols and copying MSDSs for every aerosol. Also, this is a recycling pathway (rather than a disposal pathway), which allows JCNNM to meet 40 CFR Part 261 requirements, relieve its regulatory burden and reduce its liability. However, this option requires up-front investments such as procurement of equipment, procedural development, and personnel training.

3) Accumulate aerosols for direct off-site shipments for disposal. . This option also reduces costs by eliminating the need for listing all the aerosols on a CWDR, putting FWO-SWO

item identification numbers on the aerosols and copying MSDSs for every aerosol. However, because this is a disposal pathway, JCNNM will not be able to relieve its regulatory burden or reduce its liability.

4) Accumulate aerosols for direct off-site shipments for recycling. Like the other two options, this option reduces costs by eliminating the need for listing all the aerosols on a CWDR, putting FWO-SWO item identification numbers on the aerosols and copying MSDSs for every aerosol. This is a recycling pathway and allows JCNNM to relieve its regulatory burden and reduce its liability.

The team used Figure 1 as a starting point in identifying the specific activities in the current aerosol management process, and then assigned costs to each activity. Then, the team estimated the costs of the same activities for the passive puncturing, direct off-site disposal and direct off-site recycling options. The results are shown in Tables 1 through 4.

**Table 1: Itemized Project Non-Equipment Costs for FY01**

| Resource | Current Procedure | Passive Puncture | Direct Off-site Disposal | Direct Off-site Recycle |
|---|---|---|---|---|
| Planning/Procedure Writing | $0.00 | $5,040.00 | $0.00 | $0.00 |
| Training | $0.00 | $647.50 | $240.00 | $0.00 |
| Misc. Supplies | $0.00 | $0.00 | $0.00 | $0.00 |
| Startup/testing | $0.00 | $720.00 | $240.00 | $480.00 |
| Travel | $0.00 | $0.00 | $0.00 | $0.00 |
| Readiness reviews/management assessments/admin costs | $0.00 | $375.00 | $0.00 | $6,000.00 |
| Other operating expenses | $0.00 | $0.00 | $0.00 | $0.00 |
| **Total: Projected Non-Equipment Cost = (E)** | **$0.00** | **$6,782.50** | **$480.00** | **$6,480.00** |

**Table 2: Itemized Project Equipment Funding Requirements**

| Resource | Current Procedure | Passive Puncture | Direct Off-site Disposal | Direct Off-site Recycle |
|---|---|---|---|---|
| Design | $0.00 | $0.00 | $0.00 | $0.00 |
| Purchase | $0.00 | $2,000.00 | $0.00 | $0.00 |
| Installation | $0.00 | $201.00 | $0.00 | $0.00 |
| Other equipment investments | $0.00 | $0.00 | $0.00 | $0.00 |
| **Total: Equipment Cost = (C)** | **$0.00** | **$2,201.00** | **$0.00** | **$0.00** |
| **Total Project Funding Requirements = (C+E)** | **$0.00** | **$8,983.50** | **$480.00** | **$6,480.00** |

**Table 3: ROI Calculation**

| Resource | Current Procedure | Passive Puncture | Direct Off-site Disposal | Direct Off-site Recycle |
|---|---|---|---|---|
| Equipment | $0.00 | $390.60 | $0.00 | $0.00 |
| Purchased raw materials & supplies | $0.00 | $0.00 | $0.00 | $0.00 |
| Process operation costs | $0.00 | $10.05 | $0.00 | $0.00 |
| PPE & related health/safety supply costs | $0.00 | $0.00 | $0.00 | $0.00 |
| **Waste management costs** | | | | |
| Collect waste aerosols for disposal or recycle | $2,080.00 | $0.00 | $2,080.00 | $2,080.00 |
| Inventory waste aerosols for disposal | $3,840.00 | $0.00 | $480.00 | $480.00 |
| Collect MSDSs | $1,920.00 | $0.00 | $0.00 | $0.00 |
| Prepare waste documentation | $240.00 | $12.00 | $120.00 | $120.00 |
| Inspect waste storage areas | $480.00 | $24.00 | $480.00 | $240.00 |
| Package the cans | $11,256.00 | $0.00 | $11,256.00 | $11,256.00 |
| Sample/analyze collected wastes | $0.00 | $24.00 | $0.00 | $0.00 |
| Waste Disposal Fee | $2,726.00 | $1,715.50 | $2,726.00 | $2,726.00 |
| NMED Fines | $5,000.00 | $250.00 | $5,000.00 | $0.00 |
| Lost Subcontractor Fee | $5,000.00 | $250.00 | $5,000.00 | $0.00 |
| Waste Container Costs | $400.00 | $50.00 | $400.00 | $400.00 |
| **Recycling costs** | | | | |
| Collect waste aerosols for puncture | $0.00 | $2,080.00 | $0.00 | $0.00 |
| Inspect recycling filters | $0.00 | $360.00 | $0.00 | $0.00 |
| Puncture the cans | $0.00 | $11,256.00 | $0.00 | $0.00 |
| Scrap Metal Revenue | $0.00 | -$5.28 | $0.00 | -$406.00 |
| **Total** | **$32,942.00** | **$16,416.87** | **$27,542.00** | **$16,896.00** |
| **Useful Project Life in years (L):** | **5** | **5** | **5** | **5** |
| **Time to Implement (years):** | **0** | **1** | **1** | **1** |
| **Estimated Project Termination or Disassembly Cost** | **$0.00** | **$0.00** | **$0.00** | **$0.00** |
| **ROI %** | | **163.9** | **40.1** | **158.6** |

**Table 4: Cost Summary by Item Type**

| Resource | Current Procedure | Passive Puncture | Direct Off-site Disposal | Direct Off-site Recycle |
|---|---|---|---|---|
| Labor | $19,816.00 | $20,725.55 | $14,896.00 | $20,656.00 |
| Materials | $400.00 | $2,440.60 | $400.00 | $400.00 |
| Fees | $12,726.00 | $2,215.50 | $12,726.00 | $2,726.00 |
| Sampling & Analysis | $0.00 | $24.00 | $0.00 | $0.00 |
| Scrap Metal Revenue | $0.00 | -$5.28 | $0.00 | -$406.00 |
| **Total:** | **$32,942.00** | **$25,400.37** | **$28,022.00** | **$23,376.00** |

The team used the results of the activity-based costing analyses to compare the three alternatives. As shown in Table 3, the passive puncturing alternative had the highest Return on Investment or ROI (163.9%), followed by direct off-site recycling (ROI = 158.6%). Comparison of the ROIs for each alternative suggests that passive puncturing would be an effective alternative to the current procedure.

To further examine the three alternatives, the team conducted a break-even analysis, which compares two operations based on their fixed and variable costs. Fixed costs include initial equipment purchase and set up costs, while variable costs include the labor and materials associated with performing an operation. The Break Even Point (BEP) identifies the number of cans per year at which the cost for implementing either alternative is the same. Calculating the BEP for each alternative compared to the current process and each alternative compared to passive puncturing allowed the team to better determine the most cost-effective alternative for JCNNM's expected annual waste aerosol can generation rate.

Table 5 shows the Break Even Points (BEPs) for each alternative versus the current procedure or passive puncturing. For example, the BEP for disposal by WPF and CWDR through TA-54 versus passive puncturing the cans for recycle is 870 cans per year. Table 6 shows which alternative is more cost effective above or below the given BEP. At JCNNM's current generation rate (1600 cans per year), passive puncturing and direct off-site disposal are more cost-effective than the current disposal process through TA-54 (Table 6). However, at this generation rate, the current procedure is more cost-effective than direct off-site recycling. When compared to passive puncturing at 1600 cans per year, direct off-site disposal is less cost-effective, while direct off-site recycling is more cost-effective.

**Table 5: Break Even Points**

| | Break Even Point (Cans/year) | | |
|---|---|---|---|
| Comparison | Passive Puncture | Direct Off-Site Disposal | Direct Off-Site Recycling |
| Current vs. Alternative | 870 | 142 | 646 |
| Passive puncture vs. Alternative | - | 1223 | 8360 |

**Table 6: Cost-Effectiveness in Relation to Break Even Points**

| | Most Cost-Effective Alternative | | |
|---|---|---|---|
| **Comparison** | **Passive Puncture** | **Direct Off-Site Disposal** | **Direct Off-Site Recycling** |
| Current vs. Alternative - Above BEP | Passive | Disposal | Current |
| Current vs. Alternative - Below BEP | Current | Current | Recycling |
| Passive vs. Alternative - Above BEP | - | Passive | Passive |
| Passive vs. Alternative - Below BEP | - | Disposal | Recycling |

Because it was unclear whether passive puncturing or direct off-site recycling was the most cost-effective alternative, the team considered other circumstances in determining which alternative to select. Specifically, recent procedural changes at FWO-SWO require a minimum of 1000 items to do a direct off-site shipment of any kind. In the current regulatory climate, JCNNM is required to ship aerosol cans every 90 days, at a minimum. At the current generation rate, it is unlikely that JCNNM would be able to accumulate 1000 cans every 90 days. The restrictions on direct off-site shipments, combined with the ROI results, compelled the team to select the passive puncturing alternative for implementation.

**Implementing the Alternative**

The team prepared an action plan for implementing passive puncturing. However, JCNNM has final authority for setting project funding priorities. If the project is approved, full implementation will be coordinated through the project team, which will meet quarterly to assess progress, identify and implement lessons learned, and quantify the action plan's specified metrics. Upon approval to begin full implementation, an independent person will assess progress annually and help the team identify necessary plan modifications.

The ultimate goal of implementing this action plan would be to reduce JCNNM's disposal of waste aerosol cans by 80 percent over FY 2000 levels by the end of FY 2001.

**Action Plan**
**Deadline: 2/16/2001**
**Responsible Party: Jim Stanton**

Goal #1: Purchase passive aerosol can puncture unit (J. Stanton, and V. Rodriguez)

Objectives:
- Secure ESO or JCNNM funding for unit; and
- Complete purchase request.

Goal #2: Determine unit location (V. Rodriguez)

Objectives:
- Identify most appropriate location for unit operations;
- Identify regulatory requirements associated with unit location and operations; and
- Negotiate JCNNM and facility buy-in.

Goal #3: Install unit (V. Rodriguez)

Objectives:
- Determine installation requirements, including grounding; and
- Coordinate with appropriate JCNNM and Laboratory personnel to complete installation.

Goal #4: Develop procedures (J. Stanton)

Objectives:
- Develop detailed operating procedures;
- Develop acceptance criteria (i.e., paints only);
- Develop safety documentation (hazard control plan);
- Develop waste management and sampling plans;
- Develop filter inspection protocol; and
- Perform regulatory review.

Goal #5: Complete the ESH-ID Process (J. Stanton)

Objectives:
- Ensure independent review of regulatory and facility management issues pertaining to installation and use of the passive puncture unit.

Goal #6: Develop and give training (V. Rodriguez)

Objectives:
- Develop and give operator training on operating procedures, safety documentation; waste management plan, and filter inspection protocol;
- Place reminder signs on or around the unit; and
- Audit procedural implementation quarterly.

Goal #7: Perform management readiness review (J. Stanton)

Objectives:
- Develop pre-operational checklist;
- Centralize operating, regulatory, and safety documentation;
- Establish points of contact for unit use, inspections, etc.; and
- Coordinate industrial hygiene air sampling to verify filter performance.

Goal #8: Ensure scrap metal recycling (V. Rodriguez, C. Bustamante and J. Stanton)

Objectives:
- Coordinate getting a scrap metal recycling bin near the unit; and
- Track recycling activity and revenue.

Figure 2 illustrates the sequence of implementing this action plan. The numbers correspond to the goals of the action plan.

**Figure 2. Action Plan Implementation Map**